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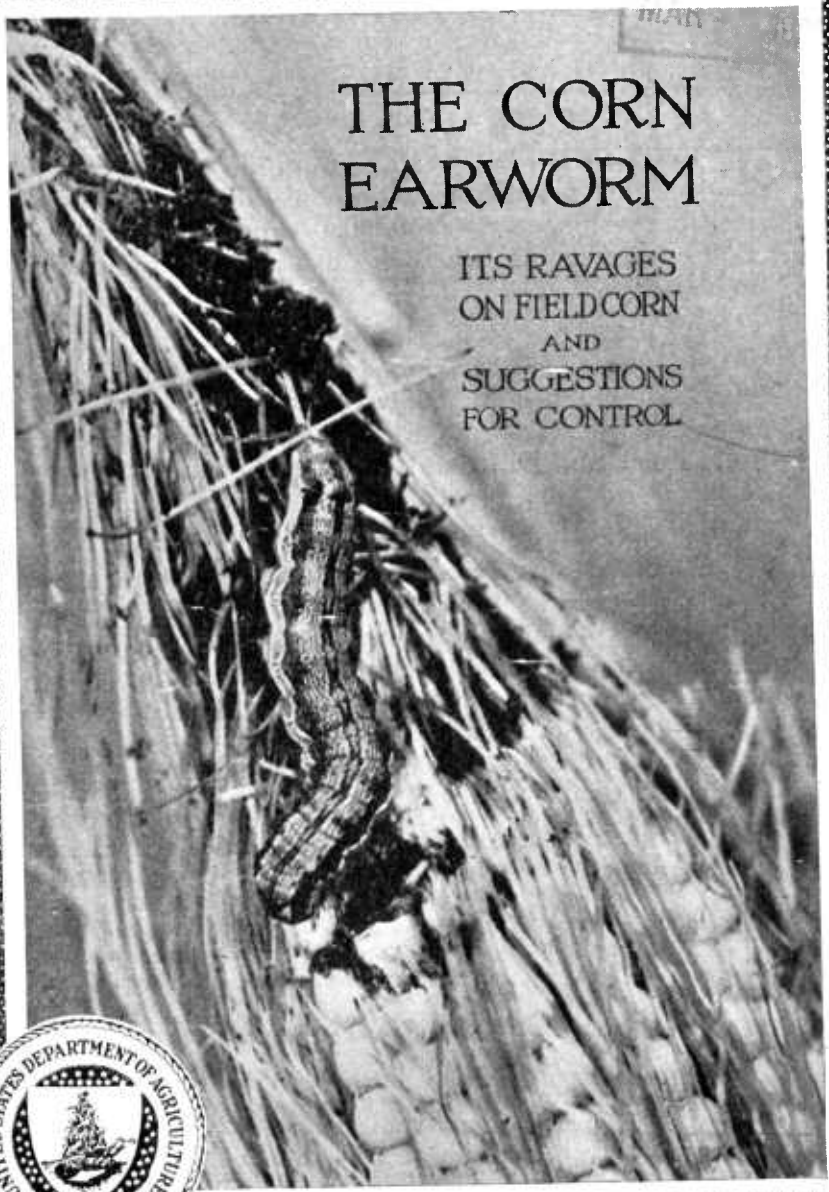
THE CORN EARWORM

ITS RAVAGES ON FIELD CORN AND SUGGESTIONS FOR CONTROL



EVERY CORN GROWER is familiar with the corn earworm, but few realize the full extent of the loss it occasions to the field-corn crop of this country. Conservatively estimated, this loss amounts annually to $40,000,000.

Each grower of corn, with little extra cost or effort, may reduce his loss from earworm ravages by at least one-half if he will select a variety of corn well suited to his local conditions, but having a long, tight husk, and will plant this variety so as to have it silk at the most favorable time—that is, when the moths of the earworm are least abundant.

This bulletin describes the different stages of the insect, and shows how it damages corn, how it is partly kept in check by its own habits and its natural enemies, and how a knowledge of its life history will aid the corn grower in protecting his crop.

Washington, D. C. January, 1923

THE CORN EARWORM:[1]

ITS RAVAGES ON FIELD CORN AND SUGGESTIONS FOR CONTROL.

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THE MOST DESTRUCTIVE CORN INSECT.

THE most destructive insect enemy of corn in the United States is the corn earworm. Its ravages vary considerably from year to year, but the damage during 1921 was perhaps the greatest yet recorded. At present it is the only insect of widespread importance which attacks the immature ears of corn. The earworm occurs throughout the United States wherever corn is grown. Green sweet corn suffers most severely from its attack. While in the North losses are heavy, in the far South the production of this favorite vegetable is rendered almost impossible by the ravages of this insect. Field corn does not suffer so severely, but it has been estimated that 2 per cent of this crop is annually destroyed by the earworm. Even at the low farm valuation of the 1920 crop of corn ($2,189,721,000)[2] this means a loss, for this crop alone, of over $40,000,000. Throughout Virginia and the other Southern States the average percentage of injury to field corn is much higher than 2 per cent, making the corn earworm of particular importance in this region.

OTHER FOOD PLANTS.

Although corn is its favorite food, this insect is also an important enemy of several other crops. On cotton it ranks, in amount of damage done, next to the boll weevil. When feeding on cotton it is

[1] *Heliothis obsoleta* Fab.; order Lepidoptera, family Noctuidae.

[2] United States Department of Agriculture Yearbook, 1920, p. 538.

called the "bollworm." Under the name of "tomato fruitworm" it is known as a very destructive enemy of early tomatoes. The late broods attack the buds and seed pods of tobacco. On vetch the ear-

FIG. 1.—Corn earworm injury to bud (at left) and tassel (at right) of corn. Reduced nearly one-half. (Quaintance and Brues.)

worm assumes migratory habits similar to those of the armyworm. Alfalfa is sometimes attacked, especially in the irrigated sections of the Southwest.

In addition to being a major pest of the crops mentioned above, the earworm larvæ can subsist on a great variety of other plants, some of which are cowpea, bean, okra, sunflower, beggarweed, crab

grass, castor bean, squash, and green peppers, to mention only a few of the more important ones.

This great variety of food plants renders the control of the corn earworm difficult. It should be remembered, however, that where corn in the milk stage is available this is attacked in preference to any other food.

HOW CORN IS DAMAGED.

In spite of the large aggregate losses due to the work of the earworm on corn, growers generally have become tolerant of the pest. This is largely due to the fact that they have been familiar with its depredations for many years and do not realize the extent of the losses caused by it.

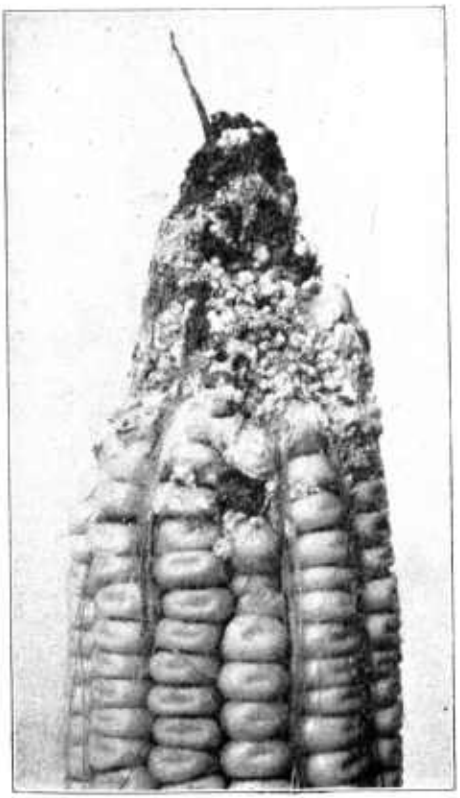

FIG. 3.—Ear showing serious earworm injury. Note abundant excrement where a large number of kernels have been entirely destroyed while soft; also partly visible earworm still feeding in the germ part of the hardened kernels. Slightly enlarged. (Photo by R. C. Smith.)

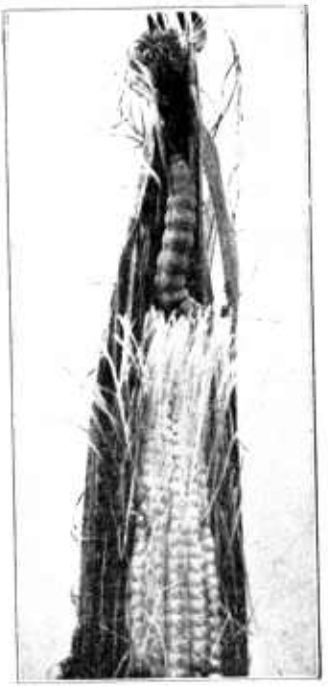

FIG. 2.—Partly grown earworm severing fresh silks before fertilization of the ear is complete. Slightly reduced. (Photo by R. C. Smith.)

The damage is caused entirely by the worms or larvæ of the insect. In the early plantings the worms attack the "buds" or central shoots, feeding on the tender unfolding leaves (Fig. 1). The extent of the loss thus caused depends, of course, on the severity of the injury to the bud itself. In 1921 the writers found that plants with "ragworm" or "budworm" injury produced, on the average, 20 per cent less of shelled corn by weight than similar uninjured plants. This loss would be very important were many plants thus injured, but fortunately only a small per cent ordinarily are found with earworms boring in the bud.

When tassels appear the few worms present immediately at-

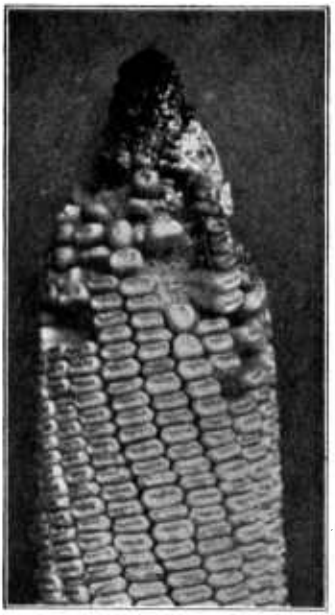

FIG. 4.—Injured ear typical of results of germ feeding by earworm. Note missing kernels. About five-eighths natural size. (Photo by R. C. Smith.)

This type of injury is important, as such kernels drop out during shucking and handling (Fig. 5) and become a total loss. Careful investigation in Virginia has shown that the actual feeding of earworms on the kernels causes from 1 per cent to 17 per cent reduction in weight of shelled corn. The writers observed one field, grown under exceptionally unfavorable conditions, where the loss due to earworms was easily 50 per cent of the crop.

The indirect injury to the ears which results from the work of the earworm is sometimes as important as the direct loss. Molds which would not otherwise gain entrance to the ears are carried in by the worms or enter with the rain through holes in the husk (Fig. 6) bored by earattack them (Fig. 1), but this feeding is of little or no importance, for the tassels are soon deserted for the ears.

After the silks appear, eggs are laid on them in preference to any other parts of the plant (Fig. 15). The young worms feed on the silks, gradually working into the developing ear. Partly matured worms, coming to the silks from the tassels, may sometimes sever the silks (Fig. 2) before fertilization is complete, causing "nubbins" or poorly filled tips. It is not known to what extent this occurs.

The principal injury occurs when the worms reach the ears, where many of the kernels are destroyed (Figs. 3 and 9) while still soft. As the kernels harden, the worms sometimes leave the corn for other food plants, but in Virginia they more often burrow under the kernels, feeding on the germ parts (Figs. 3 and 4), which remain soft for a longer period.

FIG. 5.—Hardened kernels with germ portions destroyed by earworms. Such kernels drop from ears during handling and represent serious loss. Natural size. (Photo by R. C. Smith.)

FIG 6.—Hole through husks made by earworm; such openings afford entrance to rain, molds, and weevils. About natural size. (Photo by R. C. Smith.)

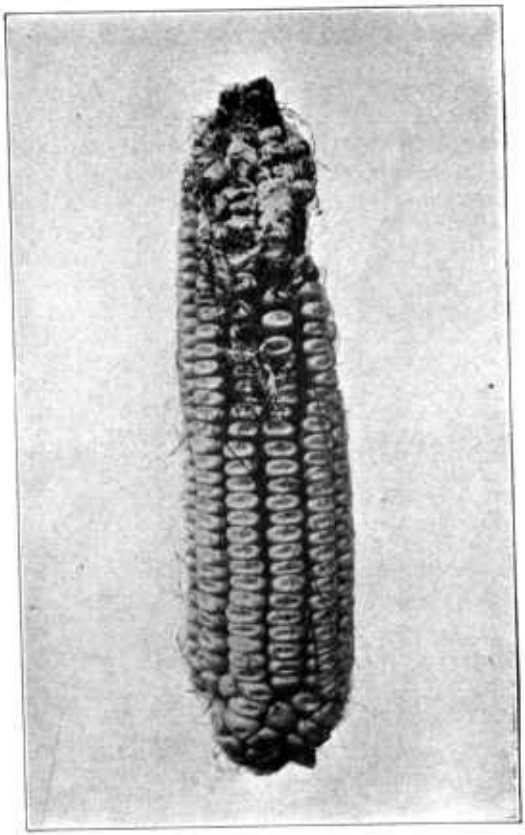

FIG. 7.—Severe earworm damage followed by mold injury. Reduced about one-half. (Photo by R. C. Smith.)

worms or at the tip where silks severed by the larvæ have fallen out (Fig. 2). Within the ear, molds breed upon the mass of excrement (Fig. 3) and damaged kernels (Fig. 7) left by the worms and often destroy the remaining uninjured kernels. Ears severely injured by molds are unsafe to use for feeding purposes, especially as food for horses.

FIG. 8.—Eggs of earworm on corn leaf. Greatly enlarged. (Photo by R. C. Smith.)

Other insects, such as the grain beetles and weevils, which are unable to enter through sound, long, tight husks, often gain admission to the ears through husks (Fig. 6) or silks (Fig. 2) injured by earworms. In the far South the work of these pests is very important. They could be largely controlled by reducing earworm injury.

It is impossible accurately to estimate the loss which in these ways is indirectly due to the earworm feeding. It is probably at least half as great as that caused by direct injury.

FIG. 9.—Nearly full-grown earworm devouring silks and soft kernels of sweet corn. Note typical striped appearance of the larva. About 1½ times natural size. (Photo by R. C. Smith.)

OTHER INSECTS CAUSING SIMILAR INJURY TO CORN.

Several other insects cause injury to the buds of young corn similar to that caused by the earworm. Among these are the larger corn stalk-borer [3], the Southern corn rootworm,[4] and the stalk-borer.[5] Where a grower has widespread injury of this type he should appeal to the entomologist of his own State or to the United States Department of Agriculture for identification of the species involved and information as to control measures.

In its feeding on the ear of corn, however, the work of the earworm is distinctive, although in some parts of the Corn Belt the fall armyworm [6] is often found in numbers feeding in the ears of late-maturing corn, and an occasional cutworm makes its way to the ear.

Another insect causing somewhat similar injury to the ears of corn is the European corn borer.[7] This pest has only recently gained admission to the United States and fortunately has as yet spread to only a small part of the corn-growing regions. Its work is readily distinguished from that of the earworm. When present the corn earworm almost invariably attacks the ears and seldom bores into cob or stalk, whereas in light infestations the European corn borer normally attacks the stalks, rarely attacking the ears. As the intensity of the infestation increases, the ears also become infested, the worms often boring up through the shank. In fields infested with the European corn borer a large number of the tassels often are broken over. Examination at the point of breakage shows a small hole filled with frass or "shavings" of the borer, and the center of the stem shows its work. This insect is present as a caterpillar in the stalks and ears of corn throughout the fall and winter, whereas during that period the corn earworm exists only as a pupa in the soil.

FIG. 10.—The corn earworm. At right, larva after entering ground and ready to pupate; in center, cast skin; at left, pupa. Slightly enlarged. (Photo by R. C. Smith.)

HOW TO RECOGNIZE THE EARWORM.

During its lifetime the corn earworm passes through four very distinct stages—the egg (Fig. 8), the larva or worm (Fig. 9), the pupa (Fig. 10), and the moth or adult (Fig. 12). Few growers, how-

[3] *Diatraea zeacolella* Dyar.
[4] *Diabrotica duodecimpunctata* Oliv.
[5] *Papaipema nebris* Guen., form *nitela* Guen.
[6] *Laphygma frugiperda* A. & S.
[7] *Pyrausta nubilalis* Hbn.

ever, are familiar with it except when, as a partly grown worm, it is feeding voraciously in the ear.

If the leaves are carefully examined in the spring a few eggs may be found. Later, when the silks are beginning to appear, the eggs are more easily detected because large numbers are often laid on the silks of a single ear (Fig. 15).

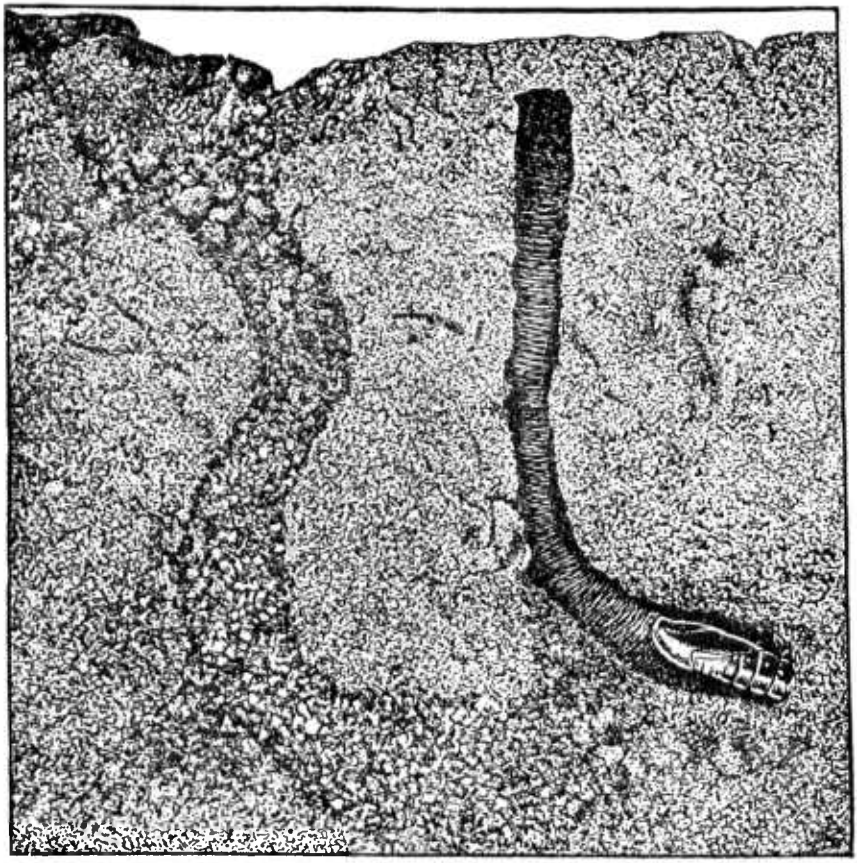

FIG. 11.—Pupa of the earworm in its burrow in the soil. Note the disturbed soil where the larva worked its way down, and the smooth channel constructed for the escape of the moth. Somewhat enlarged. (Drawn from Qualntance and Brues.)

THE EGG.

The egg (Fig. 8) is about half the size of the head of a common pin. It is shaped like a ball flattened at opposite ends. When first laid it is light yellow, but appears white against the dark green of the corn plants. It soon darkens and when ready to hatch has become a dusky brown. Hatching occurs from two to eight days after the egg is deposited, the length of time depending on the temperature.

THE LARVA OR EARWORM.

The newly hatched caterpillar is whitish, with a black head, and is very small. Growth is very rapid. The worm attains full size

in from 13 to 28 days after hatching. The increase in size is accomplished in a way known as molting. Every 2 to 5 days the old hard skin is split down the back and cast off and the worm expands greatly in size before the new skin has become hardened. Usually five molts occur during the process of growth. Each molt is preceded by an inactive period of some hours, during which the larva is helpless. When full grown (Fig. 9), the earworm is about 1½ inches long and very robust. The coloration at this time varies to a marked extent, the extremes being pale green and very dark brown. When one has become acquainted with the habits, arrangement of the stripes, and general robust appearance of the earworm, it is not easily confused with any other insect found on corn. The best way to become familiar with the larva is to open several ears of corn in midsummer and examine the larger worms (Fig. 9).

FIG. 12.—The adult or moth of the earworm resting on corn leaf. Slightly enlarged. (Photo by R. C. Smith.)

THE PUPA OR RESTING STAGE.

When full grown the larva leaves the ear, usually by boring out through the husks (Fig. 6), and drops to the ground. It enters the soil as soon as possible, and bores down to a depth of from 1 to 7 inches, varying with the hardness of the soil, moisture, and weather conditions. The larva then forms a cell (Fig. 11). In order that the moth may easily reach the surface, a smooth open passageway is constructed from the cell to within a short distance of the surface; then the larva returns to the cell, where it transforms into a pupa (Figs. 10 and 11). During this resting stage the great changes take place by which the worm becomes the moth. The pupa is light brown, about three-fourths of an inch long, and rather stout. It is very delicate and helpless. Many are destroyed by moles and other enemies, and by the disturbance of the cells in the process of plowing or harrowing. When the changes are complete the moth emerges from the pupa and makes its way to the surface, where the wings expand and harden. In midsummer the period from the time the larva leaves the ear until the moth emerges may be as short as 14 days. It is usually somewhat longer, and it may be several months, as the winter is passed while the insect is in the pupa stage.

THE MOTH OR ADULT.

The moth (Fig. 12) is about three-fourths of an inch long and has a wing expanse of 1½ inches. The coloration is dull and the shades vary considerably from a light olive green to a rather dark reddish brown. Although itself seldom attracted to lights, it is sim-

ilar to those moths which are common about lights in the summer. The moth makes itself so inconspicuous that the grower will seldom see one, unless it is noticed at midday resting in the throat of a corn plant. The moths become active in the early evening, feed on the nectar of various flowers, and then fly in search of suitable plants on which to lay their eggs.

Soon after emergence, mating takes place and egg laying begins. Each female deposits many eggs in an evening, distributed over a number of plants taken at random. The eggs are laid singly, but many may be laid on parts of one plant before another is visited. The females live about 12 days, and during this time each may deposit between 400 and 3,000 eggs, the average being about 1,000.

SEASONAL DEVELOPMENT.

The variation in the time required for each stage is due to variations in temperature. If each stage were passed in the shortest time as given above, the entire life cycle could be completed in a month. In other words, under the most favorable conditions it will require only 30 days from the time an egg is laid until the adult insect appears. In the southern part of the United States this does occur in midsummer, and there may be as many as seven generations of the earworm annually. In the extreme northern part of the country, however, there is only a single generation each year. Between these extremes the number of generations varies with the latitude, altitude, and other factors which influence seasonal temperatures. Throughout the greater part of the Corn Belt there are three or four broods annually. The number of generations largely determines the destructiveness of this pest in any given area.

FIG. 13.—Earworm egg parasitized by *Trichogramma minutum*. Greatly enlarged. (Quaintance and Brues.)

In Virginia moths begin to emerge from the overwintering pupæ during the latter part of May. Eggs of the first generation are most abundant during the latter part of June and the first two weeks of July. In the latter part of July or the first part of August, depending on the season, there is usually a period during which few or no eggs can be found by the most careful observation. Moths of the second generation soon appear, and eggs are deposited in greater abundance than before. From that time until frost eggs may always be found, the broods overlapping, though the eggs are more abundant at some periods than at others. The earliest moths of the third generation appear during the latter part of August. In Virginia it is this generation which passes the winter in the pupa stage.

Farther South the moths appear earlier in the spring, attacking corn, vetch, and tomatoes. The later generations develop on late corn, cotton, and tobacco.

NATURAL AGENCIES OF CONTROL.

CANNIBALISM.

The most important factor tending to reduce earworm ravages on corn is the earworms' habit of cannibalism. Wherever two worms come into chance contact with each other they fight until one is con-

quered. Often the uninjured worm entirely consumes its foe. Since by far the greater number of the newly hatched worms enter the ears through the silks, contact is very frequent and only a few worms survive to reach the ear. This is especially true where husks are long and tight (Fig. 17), because, in this case, the silk channel is long and narrow, and the chances for more than one survivor are greatly lessened. When husks are short or loose (Fig. 16), worms easily find their way to various parts of the ear without feeding on the silk or disturbing one another. When thus widely separated they feed unmolested and many more reach maturity. Comparatively few worms enter the ear by boring through the husk.

PARASITES AND PREDACIOUS ENEMIES.

A tiny egg parasite [8] attacks many of the eggs (Fig. 13), especially those on the leaves. Occasionally in some seasons nearly all of the eggs fail to hatch because of the work of this insect, while at other times only a few are destroyed. This parasite is very helpful, but would aid even more were means found to render it more dependable. Its work is greatly supplemented by that of a small bug [9] (Fig. 14), which, especially in late summer, destroys many of the earworm eggs laid on corn silks. This little predator appears to be of special value in Virginia.

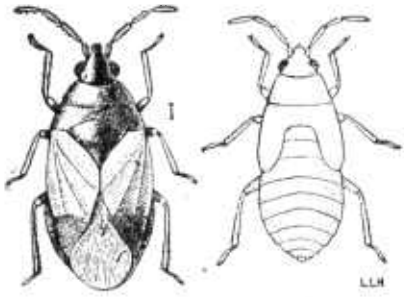

FIG. 14.—*Triphleps insidiosus:* Adult and nymph. Destroys large numbers of eggs and young larvæ of the earworm. Greatly enlarged. (Quaintance and Brues.)

Several other insects attack many of the eggs and young worms before they enter the ears. Among these enemies are two species of ladybird beetles,[10] a larger bug,[11] lacewing flies,[12] certain ants, and spiders common in cornfields.

After the worms enter the silks they are well protected from most enemies until they leave the ears. Active, dark-colored beetle larvæ [13] are important destroyers of the later broods of earworms in some sections. These predators follow their prey into the ears and kill many of them. In the fall they enter the soil and undoubtedly destroy many of the overwintering pupæ.

A few insects are parasitic on the larger earworms. A fly [14] similar in appearance to the house fly is of much importance when the corn earworm is feeding exposed on cotton and vetch, but is of little aid when corn is the food plant.

Three species not hitherto recorded as preying on the earworm have been reared from these larvæ in Virginia. A large four-winged

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[8] *Trichogramma minutum* Riley.

[9] *Triphleps insidiosus* Say.

[10] *Ceratomegilla fuscilabris* Muls. (*Megilla maculata* auct.) and *Hippodamia convergens* Guér.

[11] *Nabis ferus* L.

[12] *Chrysopa* spp.

[13] *Chauliognathus marginatus* Fab.; *Chauliognathus pennsylvanicus* De G.

[14] *Winthemia quadripustulata* Fab.

fly[15] attacks the larger larvæ and is the most important larval parasite the writers have found. A smaller species[16] has been reared from the smaller worms. A two-winged fly[17] has also been reared from the earworm.

The Bureau of Biological Survey of this department has records showing that 17 species of birds feed on the corn earworm and that the most important of these seem to be the Brewer and California red-winged blackbirds, the boat-tailed grackle, and the downy woodpecker. As many as 10 larvæ of the earworm have been found in a single stomach of the cardinal and more than 50 in one of the boat-tailed grackle.

WEATHER CONDITIONS.

Weather conditions sometimes aid in control. Heavy rainstorms destroy many eggs. Early severe frosts in the fall kill many worms before they have entered the soil. Severe winter freezes aid in destroying many pupæ. In addition, the pupæ suffer from the attacks of mice, moles, and ground beetles.

No attempt has been made to list all the parasitic and predacious enemies of the earworm, but only the more important ones are mentioned.

IMPORTANCE OF NATURAL AGENCIES.

Considered collectively, all these factors of natural control explain why only one, two, or rarely three larvæ mature on a corn plant upon which several hundred eggs have been deposited.

Were it not for the important aid rendered by these agencies the injury would be many times greater and would probably make corn growing very difficult indeed. Unfortunately, these natural agencies do not effect a sufficient degree of control to render artificial measures unnecessary.

CONTROL MEASURES.

The character of the corn crop is such as to make control of any of its insect pests unusually difficult. Expensive methods are not justifiable because of the small margin of profit and the relatively low commercial value of the crop. Furthermore, it is grown over such large areas that individual treatment of each plant is impracticable. The corn earworm is especially difficult to control because of the fact that for the greater part of its life it feeds in a protected position and can not be reached by poisons.

Spraying or dusting of the whole corn plant on a large scale is costly and ineffective. A fair degree of control may be obtained by dusting the silks, but this method is expensive and impractical for the crop as a whole.

No grower should assume from the preceding discussion that it is hopeless to expect any great reduction in earworm damage. By using the methods described herein any grower can greatly reduce his losses; and if an entire community would uniformly put these

[15] *Paniscus* sp., near *geminatus* Say.
[16] *Sagaritis dubitatus* Cress.
[17] *Sarcophaga latisterna* Park.

methods into practice, the results would undoubtedly be remarkable and could be effected with little cost.

Previous estimates of the damage done by this insect have been based on percentage of infestation, but the writers have found that the percentage of infestation is not an accurate index of the accompanying injury. By finding the total weight of shelled corn produced and the weight of kernels equivalent to those injured by the earworm, the per cent of loss can be accurately calculated. The following recommendations for control measures are, for the most part, based on fairly accurate percentages of loss under the various conditions, as found in this manner.

TIME OF PLANTING.

In Virginia the time of planting, or rather the time of silking, has been found to be the most important factor affecting earworm damage. The moths much prefer to deposit their eggs on fresh moist silks (Fig. 15), and few are placed upon plants which have dry silks. Where the crop of field corn can be brought into silk at the period when moths are least abundant, the infestation and damage are greatly reduced. With corn silking at the most favorable time, the percentage of loss has been found to be only one-fifth to one-half as great as for corn silking at any other period. This most favorable period varies with the locality and the season, and therefore the exact date of planting which each grower should use can not be definitely stated here for the country as a whole. At Charlottesville, Va., it has been found that Virginia-grown seed of Hickory King or Reid's Yellow Dent should be planted about the middle of May in the average season. Each grower should select the date that he finds best for his locality and the varieties that he grows.

In general the late-maturing and prolific varieties, which have been found to produce best on rich soil, should be planted as early in the season as is consistent with conditions favorable for germination and growth. Too early planting should be avoided, of course, because it may result in poor germination, necessitating replanting, and in slow growth and reduced yield. Replanting tends greatly to increase earworm injury and should be avoided. All of these factors considered, the first week in May is the best planting date in the vicinity of Charlottesville, Va., for long-season varieties. Midseason and early varieties should be planted somewhat later, in order that all plantings may silk at approximately the same time. Early plantings of early varieties are usually as severely injured by the earworm as late plantings of long-season varieties, because in each case the corn silks at a period of great abundance of moths.

In some areas severe injury by other insects makes early planting inadvisable. In such communities it is especially important to arrange it so that the main crop of corn all comes into silk at about the same time. A period of two or three weeks is allowable. Heaviest damage occurs when a field of late corn comes into silk at just the time when moths are emerging from near-by fields of early corn or other food crops. One instance of nearly 50 per cent loss in weight has been observed where a crop of field corn was grown under such conditions.

In sections where corn is the only important food crop of this insect the uniform and rather early silking period of the main crop will greatly reduce losses for the current year, and the lack of suit-

FIG. 15.—Ear in prime silk, at the stage when it is most attractive to the earworm adults for egg laying. Note the large number of eggs scattered through the silks. Slightly enlarged. (Quaintance and Brues.)

able food for the late broods will greatly lessen the number of overwintering pupæ, thus reducing the infestation for the succeeding year.

CHARACTER OF HUSK.

The character of the enveloping husk is a very important factor influencing earworm injury to corn. It is very desirable that the husk be at least long enough to cover well the tip of the ear, and above all it should close tightly around the silks. The writers have found that ears so protected have only half the loss in weight shown by ears of the same variety grown under identical conditions, and with the same percentage of infestation, but having loose husks. This has held true for nine varieties having different husk characters. Where husks are tight, ears with very long husks are somewhat less damaged by the earworm than ears having only moderately long husks. Moreover, very long, tight husks have been found to be of great assistance in reducing weevil injury to corn. Bird injury to corn in the field is much less in ears with long, tight husks than in those having short or loose ones (Fig. 16). Where these types of injury are important the grower and corn breeder should select for seed ears having husks which are not only tight but also quite long (Fig. 17). By such wise selection, the corn grower can obtain these desirable husk characters in the variety which he has found best suited to his needs and greatly reduce the losses from these various causes.

FIG. 16.—Undesirable husk characters. Note bird injury to exposed tip. Ears having husks of this type are especially susceptible to earworm injury. (Photo by R. C. Smith.)

VARIETY TO CHOOSE.

Varieties silking at the same time differ greatly in percentage of loss sustained from the earworm, and such variations are largely explained by the husk differences. The variety selected should be well suited to the local conditions. Late-maturing and prolific varieties when planted on thin land do not silk uniformly; they produce a large proportion of small ears and "nubbins," and are therefore more heavily damaged by earworms than smaller, earlier varieties.

SOIL PRODUCTIVENESS.

To plant corn on poor land is to invite severe earworm injury. This is because of the irregular silking and high percentage of poor ears on such soil. Fertilization, crop rotation, the use of legumes, and other measures which increase the productiveness of the land and make for a better crop of corn aid in reducing the severity of earworm injury.

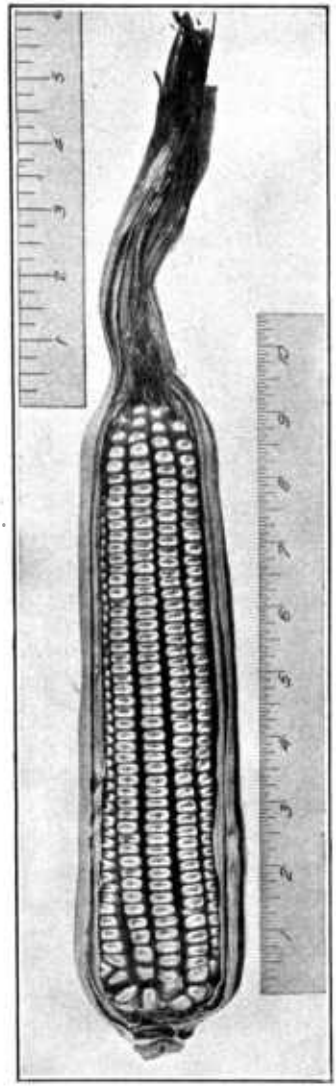

FIG. 17.—Desirable husk characters. Shuck protection like this will greatly reduce both earworm and weevil injury (Kyle.)

PLOWING.

Many writers have recommended that fields bearing crops upon which the earworms feed be plowed in the fall or winter, in order to break up the pupal cells and expose the delicate pupæ to the winter freezes. The present writers have found that in heavy soils the *time* when plowing occurs is of little consequence, as the pupæ are destroyed by this disturbance in any case. Light, friable, or sandy soils, however, that react quickly to atmospheric changes, should be plowed in fall or winter so that advantage may be taken of the destructive effects on the pupæ of frequent changes in temperature. Undoubtedly marked results could be obtained if the farmers of an entire community would plow, during the fall or winter, all the fields that have produced late corn or other crops upon which the late broods of earworms have developed. Unless all places where the insect may be found hibernating can be reached, the expense of fall plowing undertaken for this purpose alone may not be justified by the results obtained.

SPRAYING OR DUSTING THE SILKS.

The application of arsenical sprays or dusts to the silks at the time when these are attractive for oviposition is an effective means of earworm control if properly done. Because of the labor involved, however, this method is prohibitive in cost for the main crop of field corn. It is advisable for market gardeners growing sweet corn, or if corn is specially desired for seed or show purposes, where the increased value of the corn will justify the cost of treatment.

Dusting by hand, using a small sack, or a can with a top perforated like a salt shaker, is the best method of application. A mixture,

half arsenate of lead and half finely ground sulphur, has been found most effective. The first application should be made when about one-fifth of the plants have silks at the stage shown in Figure 18. The treatment should be repeated every three or four days until the silks are all dry or the ears are ready for use. There is no danger from the use of these ears as food. The treatment is especially effective where the ears treated have long, tight husks which compel most of the worms to feed on the exposed silks before gaining entrance to the ears.

FIG. 18.—Tip of ear showing silks at the stage when dusting should begin. (Photo by R. C. Smith.)

The writers have found, with field corn, that where heavy driving rains occur during the period of treatment, a considerable amount of rotten corn results. This is apparently due to the action of arsenicals driven by rain into the silks and ears.

DEGREE OF CONTROL POSSIBLE.

A question which naturally will arise in the grower's mind is, To what degree can this insect be controlled by the use of the cultural methods described in this bulletin? The writers have found that a very marked control is possible. In 1921, a year of very heavy infestation, the ears which had long, tight husks, which silked at the most favorable time, and were of a variety well suited to local conditions, had less than one-half of 1 per cent of the corn eaten by earworms. On the other hand, the worst injured variety and planting showed 17 per cent loss. This difference shows the degree of control effected by changes in cultural practice alone, without the use of arsenicals, and in the absence of community cooperation.

It appears that any energetic grower, with very little expense and moderate effort, can reduce by half the earworm injury to his field corn. A community effort would doubtless effect much better results.

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